

## DESIGN CONSIDERATIONS FOR HIGH PERFORMANCE TEXTILES

### SUMMARY OF REMARKS presented at the NASA ULDB TECHNICAL WORKSHOP by Beth Hunt Vice President/Business Director Precision Fabrics Group, Inc. June 23, 1997

Precision Fabrics Group is a privately held textile company headquartered in Greensboro, NC. PFG has four world class manufacturing facilities and a US government certified research and development laboratory located in the southeastern United States and sales offices around the world.

PFG is in the business of engineering and manufacturing textiles for technical applications. Our strength is in our research and development capabilities. We prefer to develop fabrics and fabric composites to customers' performance specifications rather than produce commodity fabrics for the general marketplace.

Among an extensive array of industrial applications, PFG is the leading supplier of finished military parachute fabrics. We also provide a wide range of process materials to the aircraft and aerospace market. We recently have begun the process of qualifying and certifying a revolutionary new ultra lightweight fabric and bag design for automotive airbags.

About 18 months ago PFG submitted a number of samples to NASA at Magdi Said's request. He was investigating the state of textile technology and how various fabrics, films, and composites might enhance the performance of high altitude balloons. We designed a number of fabrics specifically to meet his performance requirements for a high strength to weight ratio, durability, and gas permeability. I will be talking to you about some of the variables one considers when developing a high performance textile and how each may impact the efficacy of the product once it is fabricated (in this case) into a balloon envelope.

### YARN SELECTION

The initial decision to be made is selection of the yarn polymer (e.g., polyester v. nylon, et. al. ). The polymer itself will have an impact on the characteristics of the resulting fabric in terms of its hydrophilic (water absorbency) nature among other attributes. Consideration must be given to the opacity of the fiber. Manmade fibers typically range from "clear" to "dull" depending on the level of titanium dioxide that is spun into the yarn. This yarn variable will have a direct effect on the fabric's radiative properties.

The shape of a yarn's cross-section is another characteristic that is a determinant of the fabric's radiative properties. This is because the light reflective characteristics of the yarn is a function of its surface area and shape. Fiber is available in a wide variety of cross-section shapes (e.g., round, trilobal, triangular). The yarn cross-section also influences how highly constructed (the number of yarns/square inch is referred to as "yarn count") a fabric might be.

Manmade filament yarns may be flat, twisted, or textured. This variable can affect a fabric's porosity and its propensity for mechanical adhesion properties which may contribute to the ease with which it can function as a film composite substrate.

Other additives may be spun into yarn. One, of import to a balloon textile, is copper which enhances the fabric ultraviolet ray resistance and durability. During the yarn manufacturing process, the tenacity of the yarn is established. Tenacity determines the yarn's strength and elongation properties. Finally, the fiber's "denier" (or diameter) is a determinant of a fabric's weight, thickness, and strength, all other variables being constant.

## FABRIC DESIGN

One of the first considerations in fabric design is determining the fabric's construction. The yarn count has a direct effect on the fabric's strength, weight, thickness, and porosity or air permeability. The weave pattern (plain, twill, ripstop, et. al.) also may contribute to its permeability, tear strength, and flexibility/packing volume. The weave pattern and construction, combined, will have a direct effect on its seam strength and seam slippage characteristics.

Even selecting a fabric's width has a potentially significant impact on the fabric's efficacy in its end use. For example, if the fabric is to be cut and sewn, selecting a width designed to minimize cut waste will reduce the cost of manufacturing. In the specific application of a large balloon envelope constructed of multiple gores, wider fabric reduces the number of gores and the requisite number of required seams - a further reduction of fabrication cost.

After a fabric is woven, it may be "finished". By definition, this step may include any of several processes: scouring, fabric stabilization, mechanical treatments, application of chemicals and dyes. Selection of the appropriate processes and chemistry is critical as a diverse range of performance properties can be imparted to the fabric. These include, but are not limited to: static control or dissipation, color and opacity, surface texture, flexibility, chemical properties, hydrophilicity, antimicrobial properties, cleanliness, affinity (or preparation) for coating or lamination. Coating and lamination may also be considered a finishing process. Film or coating selection offers the opportunity to further impart or enhance the fabric or fabric composites' performance characteristics and is a topic that I will defer to our next speaker, David McGill of Dimension Polyant, to discuss.

Thank you for your attention. For further information please feel free to contact me at:

PRECISION FABRICS GROUP  
SUITE 600, 301 N. ELM STREET  
GREENSBORO, NC 37401  
(910) 279-8009 - office phone  
(910) 279-8002 - facsimile  
(910) 279-8001 (ext 8009) - voice mail  
Bethhunt@aol.com - e-mail